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A SHORT REVIEW AND APPEAL

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FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
Rome, December 1968

MI/82963

FAO Fisheries Circular (FAO Fish. Circ.)

A vehicle for distribution of short or ephemeral notes, lists, etc., including provisional versions of documents to be issued later in other series.

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Growing interest has been shown recently by various people concerned with fisheries science and administration, in the possibilities of increasing production of the sea and making the fish and other commercial important marine animals easily available to mankind, in a more rational way than by classical fishing methods.

Marine farming, the breeding of marine animals in ponds, protected bays and artificially enclosed basins is one way to increase production from limited marine areas. Another way is by constructing artificial reefs or "fish houses", both offshore and inshore, to attract and concentrate fishes for commercial and sport fishermen.

The phenomenon known scientifically as thigmotropism "the desire of fish to be close to a solid object" (Breder and Nigrelli, 1938) has long been familiar to hook-and-line fishermen all over the world. Wherever there is a sunken boat or ship, fish are easier to catch, and in larger quantities, than in other places; fishing there is, in fact, often even better than around natural rocks or reefs. Japanese fishermen have known about this phenomenon since ancient times, and now improve the natural environment in sea areas close to their homes and villages by dumping solid large objects into the sea in a planned way. They recognise two types of such artificial reefs or fish apartments. One is the "tsukiiso" (constructed beach) type, around and on top of which algae, sponges, tunicates, and numerous small invertebrates grow and provide a substrate community in which commercially valuable invertebrates such as abalone, sea-urchins, sea cucumbers, and lobsters find food and protection. This type is constructed mostly from artificial rocks or by using explosives to fracture natural reefs and rocks.

The second type is the "gyosho", an artificial reef specially constructed for attracting fish. The gyosho are constructed from junk, trees, broken boats filled with waste and all kinds of solid and semi-solid trash. More recently hollow concrete blocks, constructed especially for increasing populations of mullets and porgy, are used in the gyosho.

In the last ten years, the Government of Japan after recognizing the importance of artificial reefs and fish apartements, has invested millions of dollars in this method of improving the marine habitat. Several fisheries research institutions in Japan are involved in theoretical and practical studies of the problem.

Ogawa and Takemura (1966a, 1966b), Ogawa and Onoda (1966), Sato (1963, 1964, 1965) and others are studying the behaviour of fish, especially thigmotropism towards solid objects made of various construction materials and different shapes of the "apartments". As a result of these investigations many thousands of concrete blocks, each of about one cubic meter, have been dumped in the sea, and successful fishing conducted around them.

In the United States extensive investigations of artificial reefs and utilization of sunken ships as objects of study of thigmotropism have taken place in the last decade (Carlisle, 1958, 1963; Carlisle, Turner and Ebert, 1964; Turner, Ebert and Given, 1964, 1965; Troud, 1961; Stroud and Jenkins, 1961; Stroud and Massman, 1964 etc.). Unger and Bolster (1966) prepared a comprehensive review of the efforts made to develop artificial reefs in the U.S.A. This was published under the auspices of the American Littoral Society, an active conservation oriented organization which had made a major effort to study and promote the construction of effective artificial reefs and preserve sunken ships in order to develop new fish communities.

Since World War I sunken ships have been recognized as unusually productive spots for fish. Recently Mathews (1966) measured the primary production of an artificial reef between May and August and found that 13 to 207 mg of carbon per hour were fixed in one cubic meter of sea water, in comparison with 9 to 34 mg outside the reef. Measurements of the direct effect of reef construction on fish population are also available.

In April 1960, an artificial reef of 800 concrete blocks (16 x 8 x 8 in) was constructed on a sea-grass bottom in about 30 ft of water in Lesser Lameshur Bay, St. John, Virgin Island. About 2⅓ years later, a total of 2,754 individuals of 55 species of fishes, weighing about 192 lb, were removed from the reef. This represented an average of nearly 3.2 lb /yd^2 of concrete block (equivalent to 14,514 lb per acre of block surface). Extensive sampling was also made of the fish population occuring on the natural fringing reef of St. John. A total of 1,352 individuals of 103 species of reef-dwelling fishes weighing a little over 211 lb were removed from one of the sampling areas. This represents an average of close to 0.3 lb /yd^2 of the study area (equivalent to 1,427 lb per acre of natural reef surface). Results were almost exactly the same at a second sampling area (Randall, 1963). Thus the artificial reef contained 10 times more concentration of fish than the two natural fish areas of St. John shore (Stroud and Massman, 1966). Other examples are summarized in Oren (1968).

The idea of constructing similar reefs in other parts of the world is spreading. In Italy efforts are being made to convince industry to begin experimenting with artificial reefs using scrap cars (Bini, 1967).

Much information exists on various construction materials used for artificial reef as well as on the behaviour of fish towards the different artificial habitats. Some basic principles which can be used in the practice of reef construction, regarding bottom quality, wave action, etc. are already known; for instance small and low objects have proved best for promoting the growth of seaweeds; structures with many holes and crevices are best for attracting invertebrates; for fish, the higher and larger structures are more effective.

There have also been some developments in establishing artificial reefs in Israel where the coastline is without bays or islands and, in most cases, the inshore bottom is sandy. In addition to improving such a marine habitat, Oren (1966) mentioned other aspects which might be beneficial and important. The Israeli coastline now offers little to sport fishermen.

Artificial reefs could provide both adults and young people with an excellent activity for their leisure time. Another advantage would be the cleaning of the increasing quantities of scrap accumulating near garages, workshops, military camps etc. of coastal towns and cities. The planned dumping of old motor cars, railway cars, tractors, agricultural machineries, etc. would improve the countryside and with closer collaboration between the different authorties, provide a common solution to their problems. Artificial reefs could also be beneficial in large bodies of fresh water.

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